National Institute of Environmental Health Sciences

# Development of temporal modelling for forecasting and prediction of malaria infections using time-series and ARIMAX analyses: A case study in endemic districts of Bhutan

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**Abstract:**

BACKGROUND: Malaria still remains a public health problem in some districts of Bhutan despite marked reduction of cases in last few years. To strengthen the country's prevention and control measures, this study was carried out to develop forecasting and prediction models of malaria incidence in the endemic districts of Bhutan using time series and ARIMAX. METHODS: This study was carried out retrospectively using the monthly reported malaria cases from the health centres to Vector-borne Disease Control Programme (VDCP) and the meteorological data from Meteorological Unit, Department of Energy, Ministry of Economic Affairs. Time series analysis was performed on monthly malaria cases, from 1994 to 2008, in seven malaria endemic districts. The time series models derived from a multiplicative seasonal autoregressive integrated moving average (ARIMA) was deployed to identify the best model using data from 1994 to 2006. The best-fit model was selected for each individual district and for the overall endemic area was developed and the monthly cases from January to December 2009 and 2010 were forecasted. In developing the prediction model, the monthly reported malaria cases and the meteorological factors from 1996 to 2008 of the seven districts were analysed. The method of ARIMAX modelling was employed to determine predictors of malaria of the subsequent month. RESULTS: It was found that the ARIMA (p, d, q) (P, D, Q)s model (p and P representing the auto regressive and seasonal autoregressive; d and D representing the non-seasonal differences and seasonal differencing; and q and Q the moving average parameters and seasonal moving average parameters, respectively and s representing the length of the seasonal period) for the overall endemic districts was (2,1,1)(0,1,1)12; the modelling data from each district revealed two most common ARIMA models including (2,1,1)(0,1,1)12 and (1,1,1)(0,1,1)12. The forecasted monthly malaria cases from January to December 2009 and 2010 varied from 15 to 82 cases in 2009 and 67 to 149 cases in 2010, where population in 2009 was 285,375 and the expected population of 2010 to be 289,085. The ARIMAX model of monthly cases and climatic factors showed considerable variations among the different districts. In general, the mean maximum temperature lagged at one month was a strong positive predictor of an increased malaria cases for four districts. The monthly number of cases of the previous month was also a significant predictor in one district, whereas no variable could predict malaria cases for two districts. CONCLUSIONS: The ARIMA models of time-series analysis were useful in forecasting the number of cases in the endemic areas of Bhutan. There was no consistency in the predictors of malaria cases when using ARIMAX model with selected lag times and climatic predictors. The ARIMA forecasting models could be employed for planning and managing malaria prevention and control programme in Bhutan.

**Source:** http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2941685

## Resource Description

**Climate Scenario :**

specification of climate scenario (set of assumptions about future states related to climate)

Other Climate Scenario

**Other Climate Scenario:** multiplicative seasonal Auto-regressive Integrated Moving Average (ARIMA)

**Early Warning System:**

resource focus on systems used to warn populations of high temperatures, extreme weather, or other elements of climate change to prevent harm to health

A focus of content

**Exposure :**

weather or climate related pathway by which climate change affects health

Precipitation

**Geographic Feature:**

resource focuses on specific type of geography

None or Unspecified

**Geographic Location:**

resource focuses on specific location

Non-United States

**Non-United States:** Asia

**Asian Region/Country:** Other Asian Country

**Other Asian Country:** Bhutan

**Health Impact:**

specification of health effect or disease related to climate change exposure

Infectious Disease

**Infectious Disease:** Vectorborne Disease

**Vectorborne Disease:** Mosquito-borne Disease

**Mosquito-borne Disease:** Malaria

**Intervention:**

strategy to prepare for or reduce the impact of climate change on health

A focus of content

**Mitigation/Adaptation:**

mitigation or adaptation strategy is a focus of resource

Adaptation

**Model/Methodology:** ☑

type of model used or methodology development is a focus of resource

Outcome Change Prediction

**Resource Type:** ☑

format or standard characteristic of resource

Research Article

**Timescale:** ☑

time period studied

Short-Term (

**Vulnerability/Impact Assessment:** ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content